■ Machine Learning Roadmap (6 Months)

This roadmap provides a structured 6-month learning plan to become proficient in Machine Learning. Each month covers focused topics with detailed descriptions, explanations, and outcomes.

➡■ Month 1 — Foundations (Math + Python)

Python for Data Science: Learn the essential Python libraries for ML: NumPy (numerical arrays & math), Pandas (data manipulation), and Matplotlib/Seaborn (data visualization). These tools will help you prepare, analyze, and visualize datasets. Outcome: You can clean, preprocess, and explore any dataset efficiently.

Mathematics Refresher: Build strong foundations in the math that powers ML models. Focus on: Linear Algebra (vectors, matrices, dot products), Probability (distributions, Bayes theorem), and Calculus (derivatives, partial derivatives, optimization). Outcome: You'll understand the core math behind ML algorithms.

Mini Projects: Apply Python and Math knowledge: explore Titanic dataset survival rates with Pandas and Seaborn, simulate probability experiments (like dice rolls). Outcome: Practical confidence with tools and math basics.

➡■ Month 2 — Core ML Concepts

Supervised Learning: Dive into regression and classification models. Learn Linear Regression for predicting numerical values and Logistic Regression for binary classification problems. Explore concepts like cost functions and gradient descent. Outcome: You can train, evaluate, and interpret simple predictive models.

Unsupervised Learning: Understand clustering (KMeans, DBSCAN) and dimensionality reduction (PCA). These techniques help find hidden patterns and simplify high-dimensional data. Outcome: You'll know how to group unlabeled data and extract meaningful structure.

Projects: Predict house prices using regression. Cluster customer segments with KMeans. Outcome: Experience applying ML to real-world datasets.

➡■ Month 3 — Practical ML & Scikit-Learn

ML Workflows: Learn how to structure end-to-end ML projects. Cover train/test splits, cross-validation, pipelines, and preprocessing (feature scaling, categorical encoding). Outcome: You can build reusable and clean ML workflows.

Model Evaluation: Study evaluation metrics: Accuracy, Precision, Recall, F1, ROC curves. Learn about overfitting, bias-variance tradeoff, and regularization techniques (L1/L2). Outcome: You'll know how to measure model quality and avoid common pitfalls.

Projects: Build a Spam Email Classifier and Titanic survival prediction model using pipelines and metrics. Outcome: Practical applied ML experience.

➡■ Month 4 — Neural Networks & Deep Learning

Neural Network Basics: Understand perceptrons, activation functions (sigmoid, ReLU), forward propagation, and backpropagation. Manually build a neural network with NumPy to grasp fundamentals. Outcome: A solid mental model of neural nets.

Deep Learning Frameworks: Learn TensorFlow or PyTorch for real-world neural networks. Train a Multi-Layer Perceptron on MNIST digits. Explore optimizers (SGD, Adam), dropout, and batch normalization. Outcome: You can train your first neural networks.

Project: Handwritten digit recognizer (MNIST). Outcome: A complete deep learning project under your belt.

➡■ Month 5 — Specialized Topics

Natural Language Processing (NLP): Work with text: Bag of Words, TF-IDF, Word embeddings (Word2Vec, GloVe). Outcome: You can preprocess and classify text data.

Computer Vision (CV): Learn Convolutional Neural Networks (CNNs) for image recognition tasks. Outcome: Ability to build image classifiers.

Time Series Forecasting: Explore ARIMA models and recurrent neural networks (RNNs). Outcome: Skills to forecast temporal data like sales or stock prices.

Recommendation Systems: Build recommenders using collaborative filtering and matrix factorization. Outcome: Understanding of personalization systems.

➡■ Month 6 — Advanced & Real-World ML

MLOps Basics: Learn model deployment using Flask/FastAPI, containerization with Docker, and model versioning practices. Outcome: You can serve ML models as APIs in production.

Advanced ML: Explore powerful algorithms like XGBoost, LightGBM, and transfer learning using pre-trained models (ResNet, BERT). Outcome: You can tackle state-of-the-art ML problems.

Capstone Project: Choose a project: build an end-to-end ML pipeline or compete in a Kaggle competition. Outcome: Portfolio-ready project demonstrating your ML expertise.

■ End State: By the end of 6 months, you'll be confident with ML foundations, practical tools, and have portfolio-ready projects to showcase your skills.